Ancillary Services from Wind Farms

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Ancillary Services from Wind Farms

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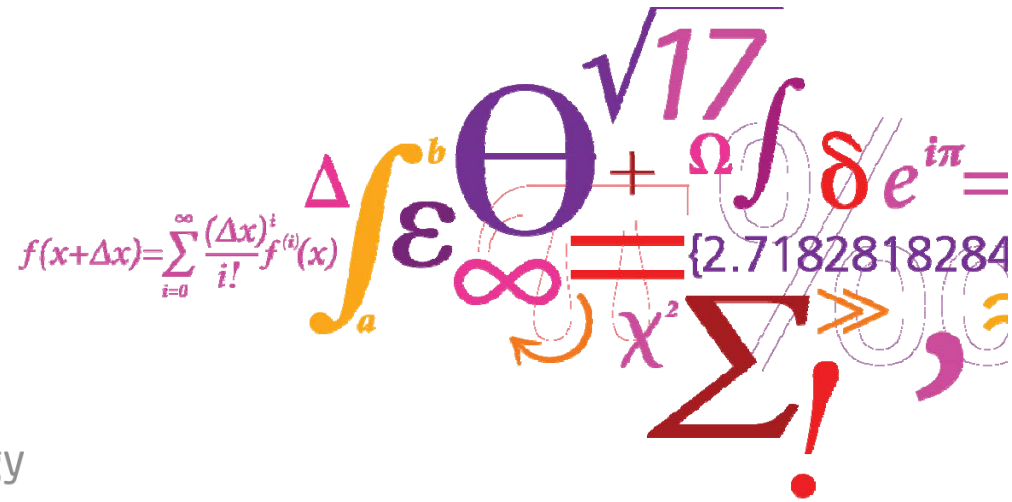


Risø DTU
National Laboratory for Sustainable Energy

Ancillary services

Ancillary Services are support services in the power system, particularly those which are necessary to support the transmission capacity and are essential in maintaining power quality, reliability and security of the grid

Classification (Alvarado, 1996):
Real vs reactive power, time and insurance

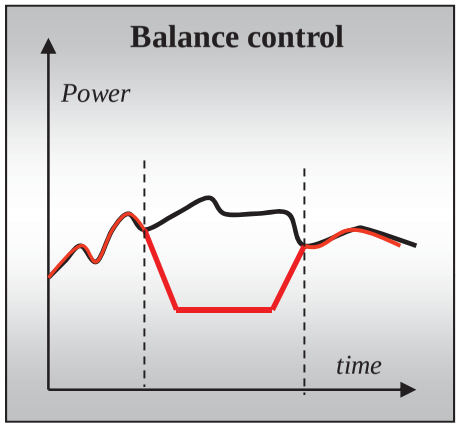
Real power: **frequency regulation**, ramping schedules, energy imbalance, loss compensation and unit commitment

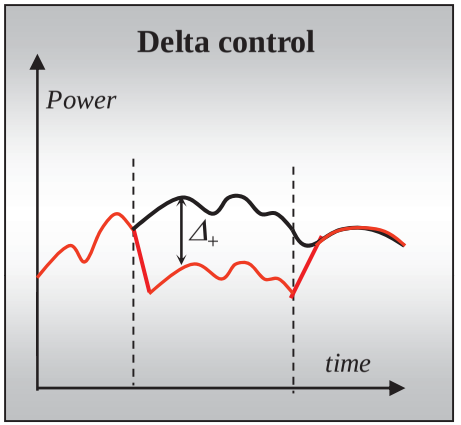
Reactive power: **voltage regulation**, capacitor switching and generator scheduling

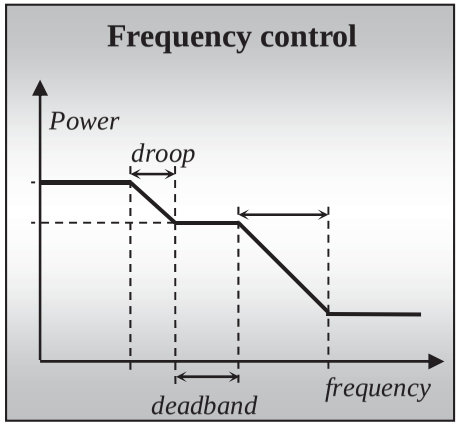
Danish TSO requirements

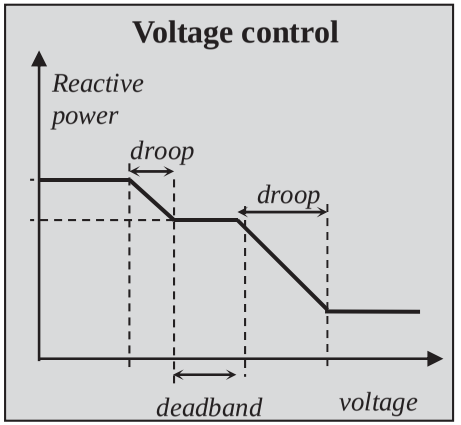
Danish TSOs requirements:

- Fault Ride Through Capabilities
- Power control Capabilities:
  - Active power control functions:
    - Balance control
    - Delta control
    - Power gradient limiter
    - Automatic frequency control
  - Reactive power control functions:
    - Reactive power control
    - Automatic voltage control









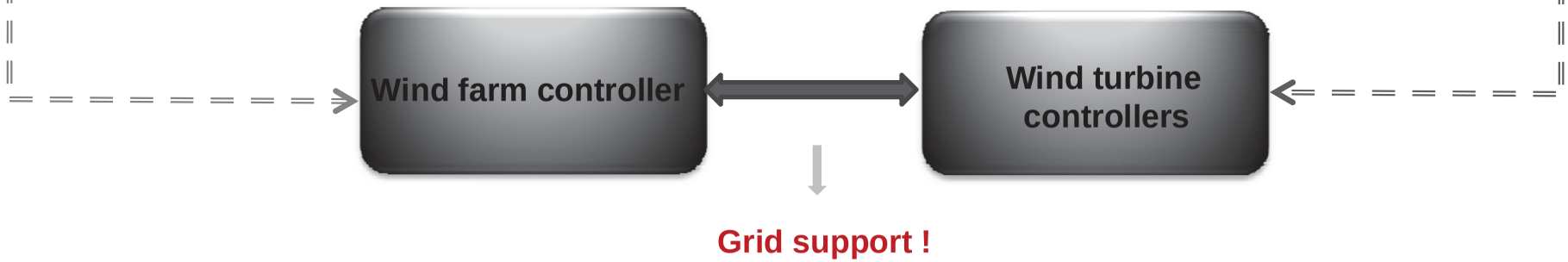
Wind turbine control

Traditionally:

- to produce maximum possible power
- to reduce the structural loads on the mechanical components and thus theirs costs

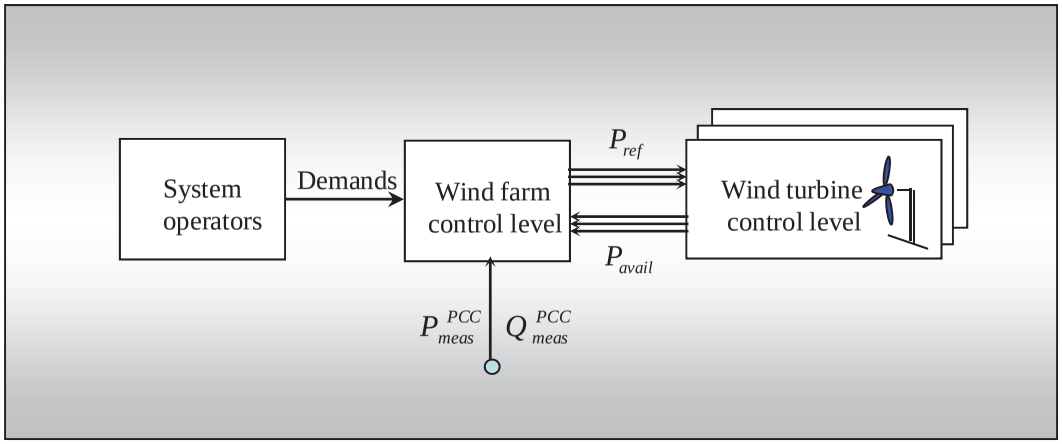
Additionally now:

- to optimize the integration of the wind turbines in the power system, in order to secure quality, stability and reliability
- to reduce the required grid connection costs



Grid support !

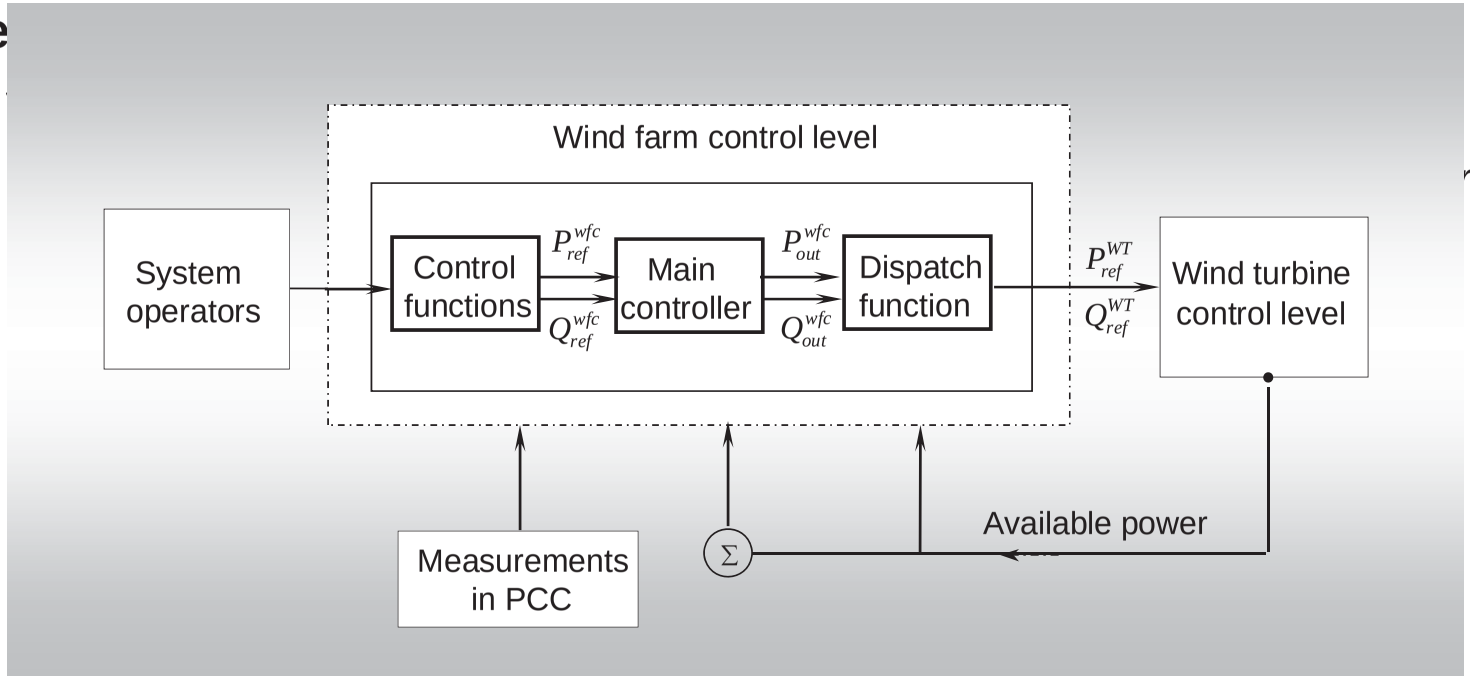
Wind farm hierarchical supervision



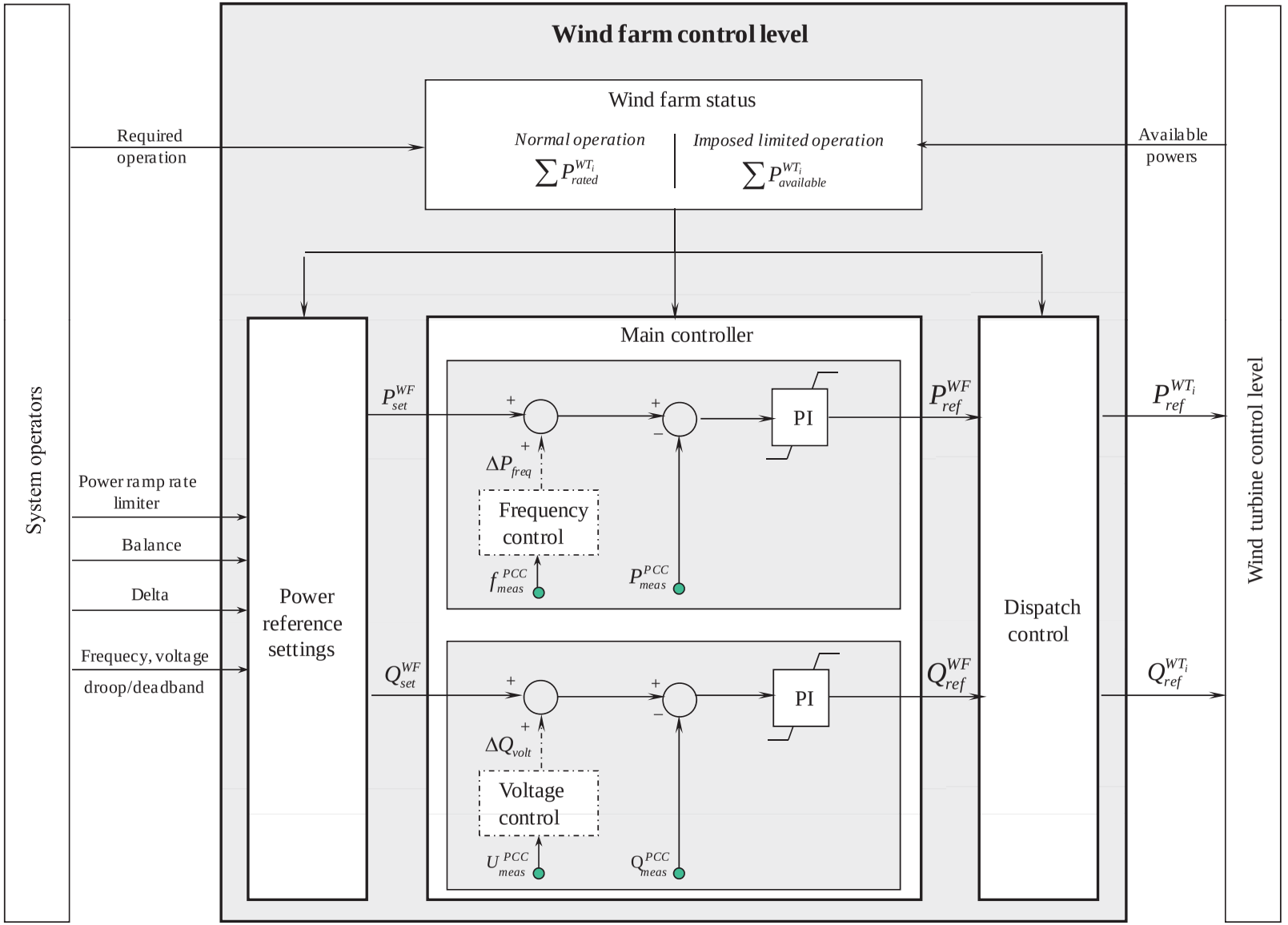
Wind farm controller's goal is to meet grid integration challenges !

Syste

- *rol tasks)*



Wind farm control level



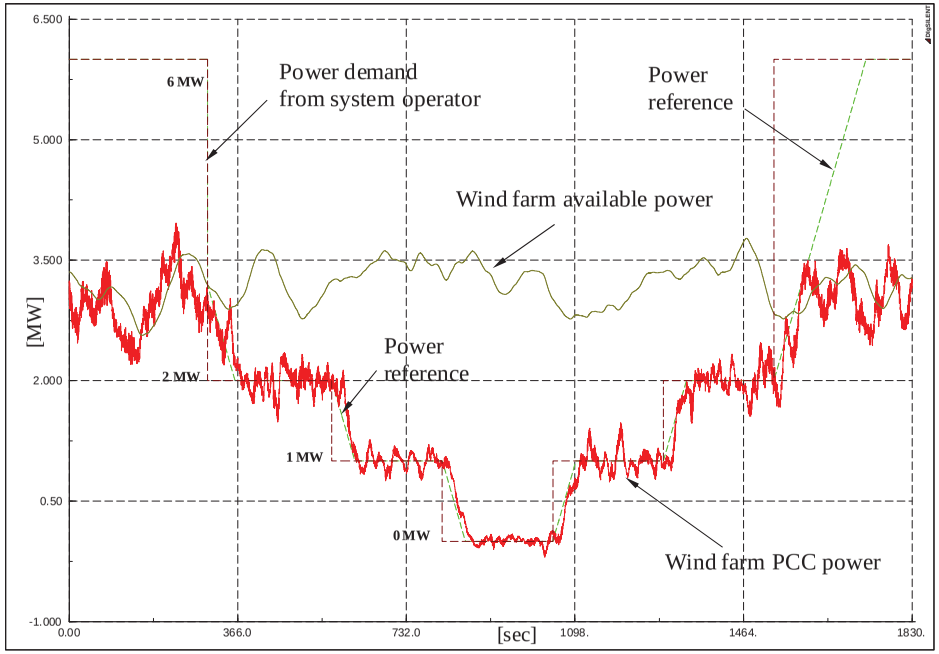
Power control grid support: ASWT wind farm

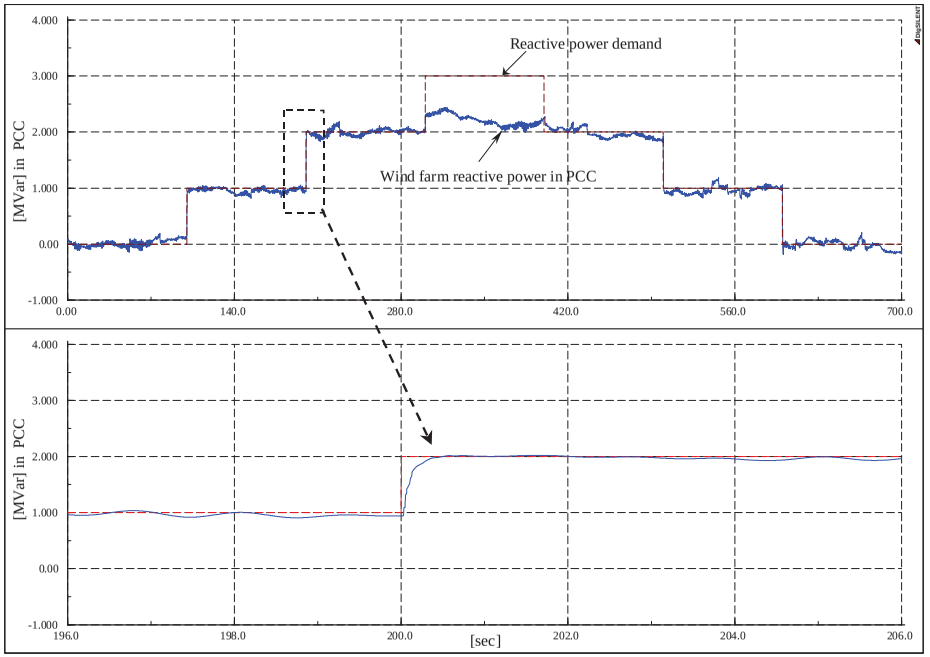
ASWT equipped with appropriate controller:

- can provide a relativelly fast response to changes in active power demands.
- new P setpoint reached within a few seconds

Dynamic phase control

- immediate response to Q demands
  (*in the limits of capacitor bank)*
  - ➢ new Q reference reached in less than 0.5 s.
- quickly control of voltage





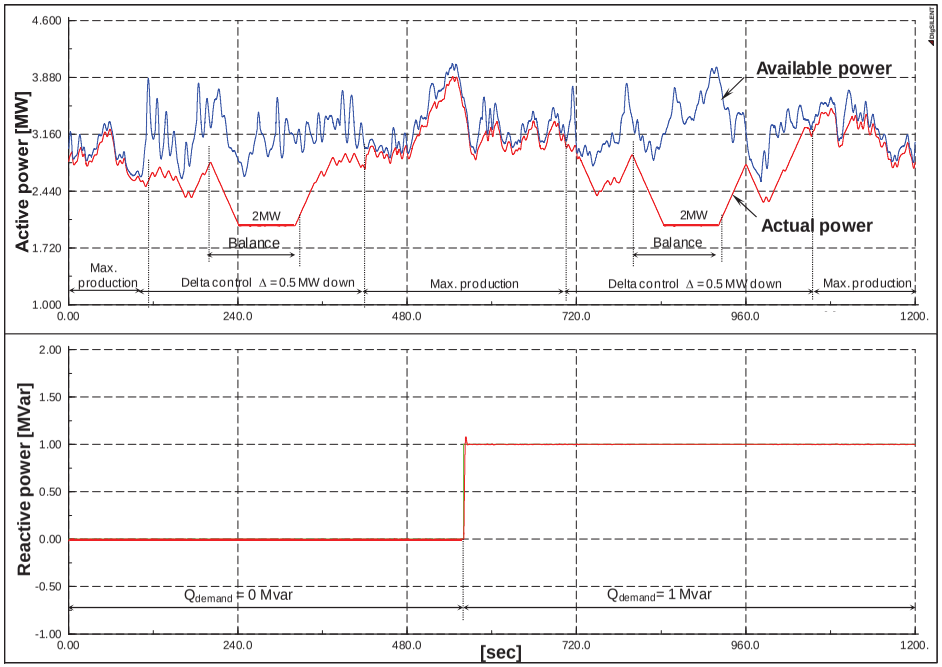
Power control grid support: DFIG/PMSG wind farm

Variable speed wind turbines (DFIG or PMSG)

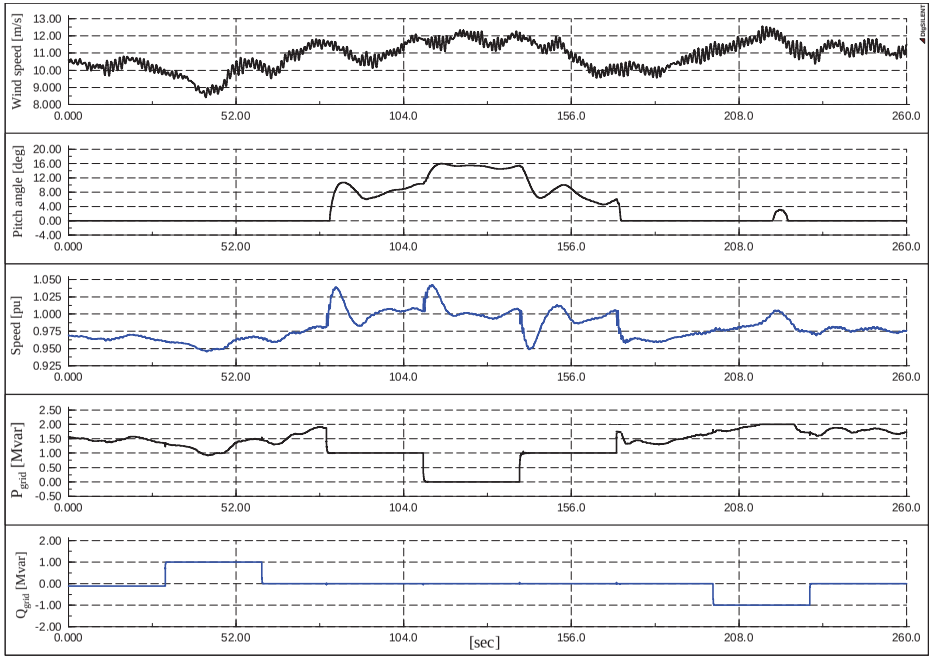
- respond immediately to changes in P and Q demands from power system operator.
- control independently P and Q

PMSG have better grid support capability than **DFIG**

- *can provide a higher amount of reactive power*
- *can support voltage level to a higher level*
- *recovers faster the voltage*



DFIG wind turbine

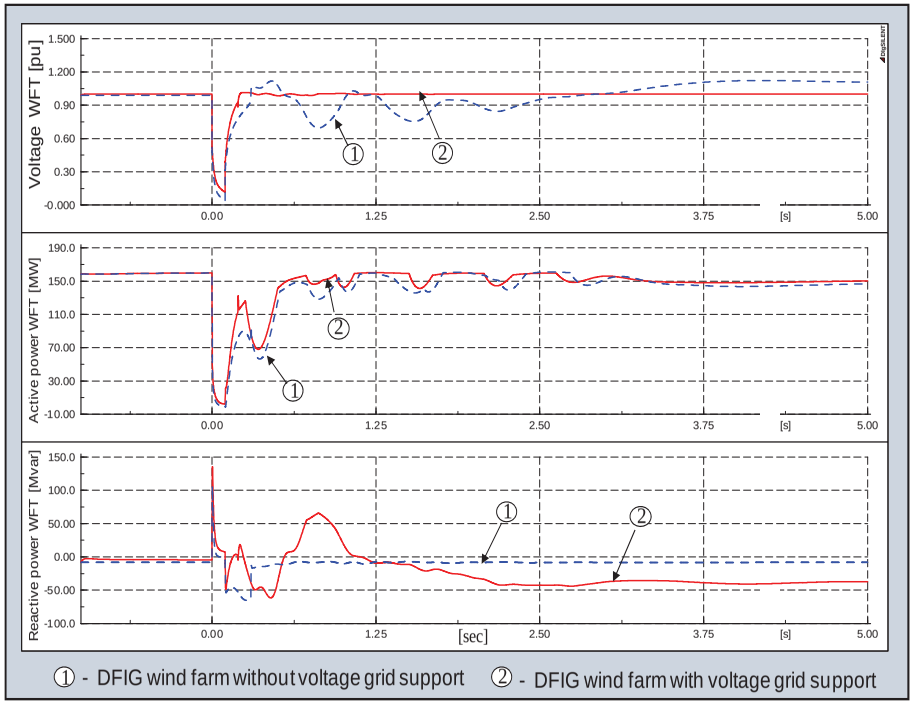


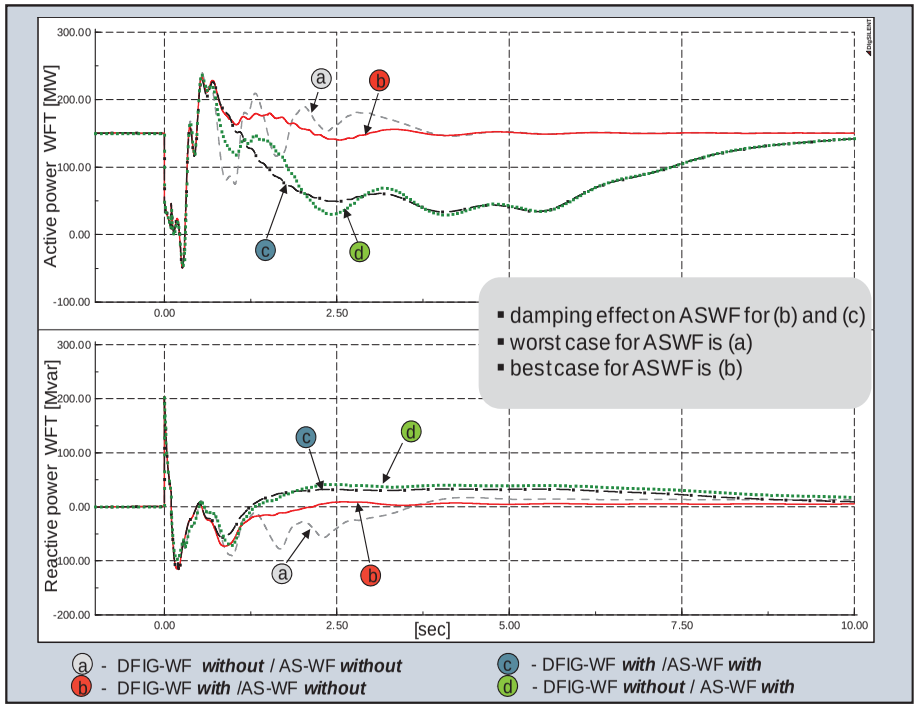
PMSG with full scale converter wind turbine

Voltage control grid support DFIG/PMSG wind farm

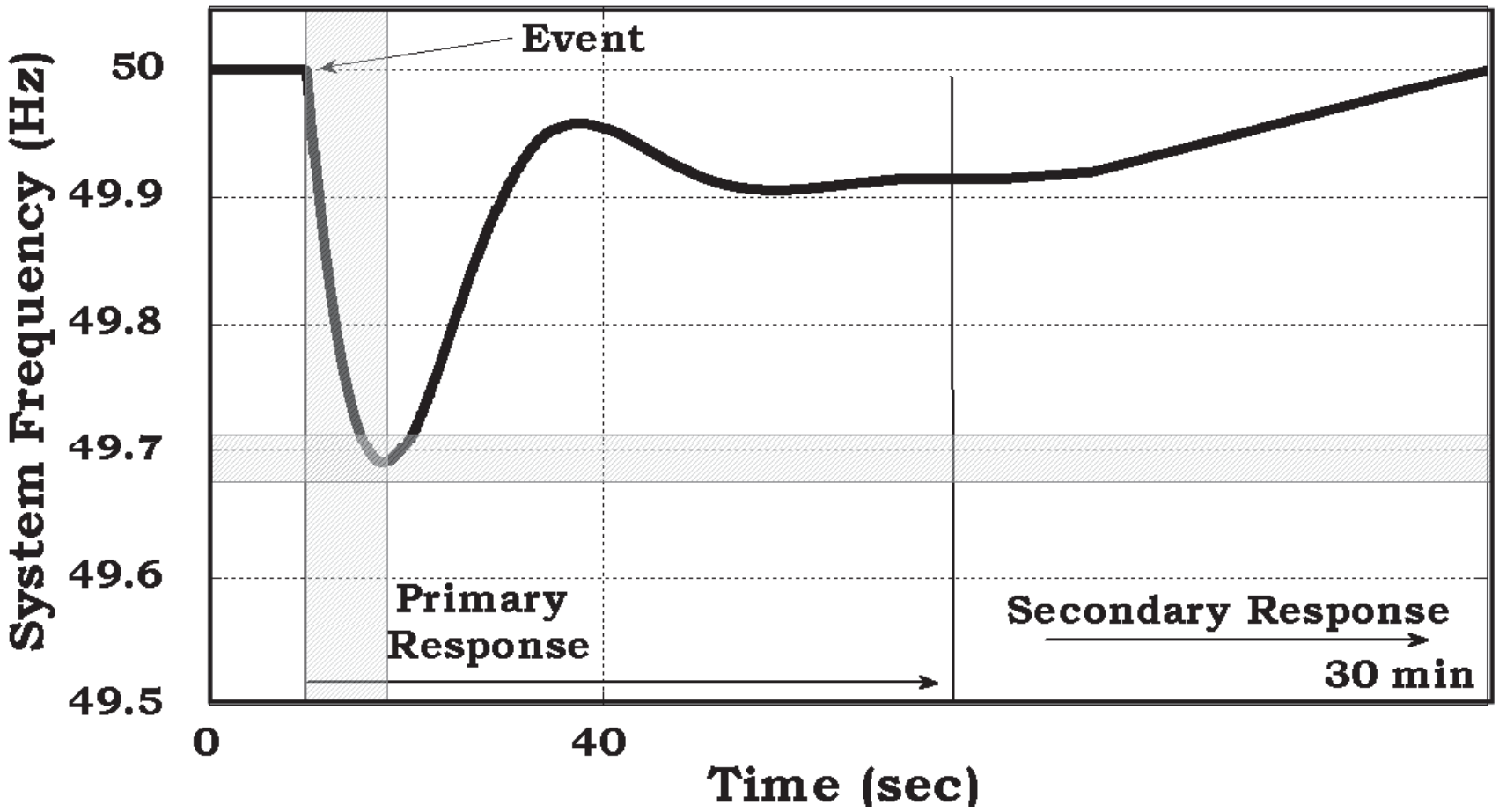
Variable speed wind turbines (DFIG or PMSG)

- participate to properly reestablish the grid voltage during a grid fault.
- can help a nearby active stall wind farm to FRT, without any additional ride through control setup in the nearby active stall wind farm



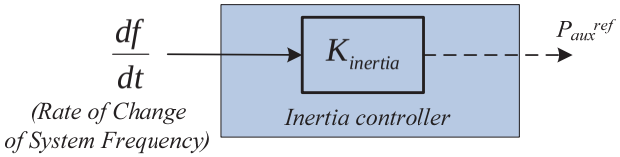


Frequency control

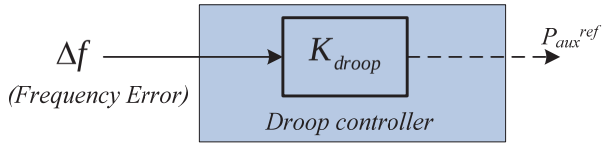


Frequency control – primary response

(i) Inertia Control ("virtual inertia")



(ii) Droop Control



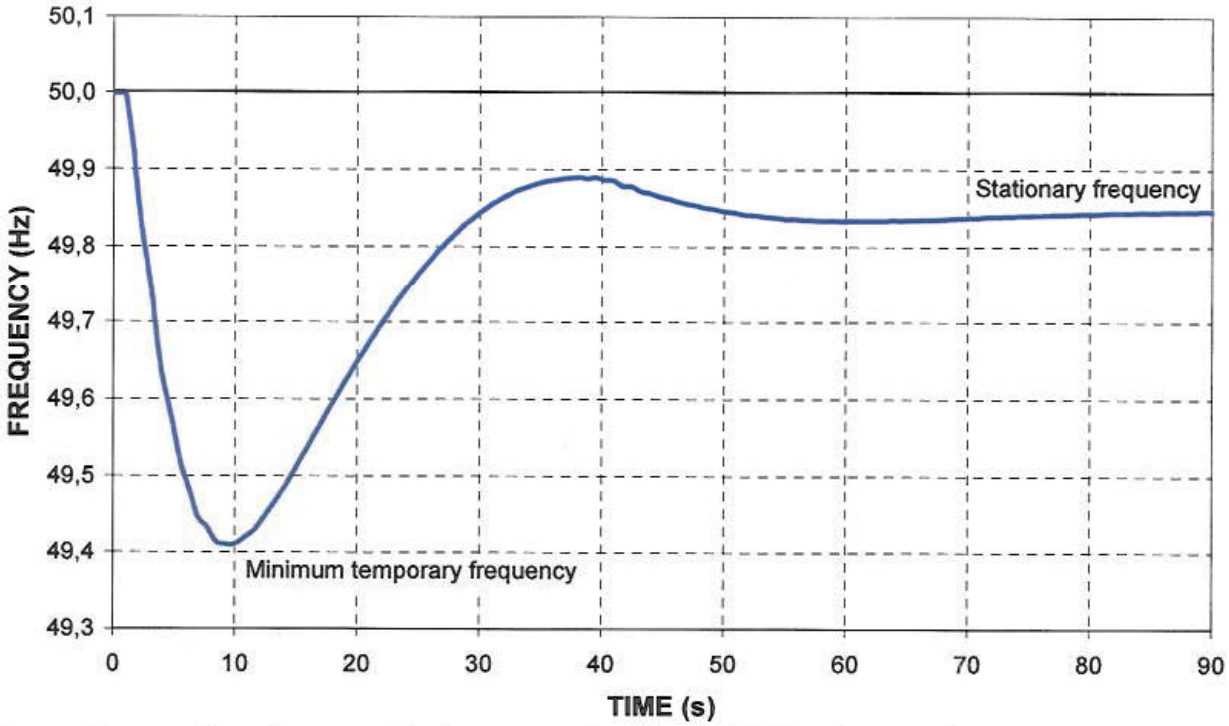
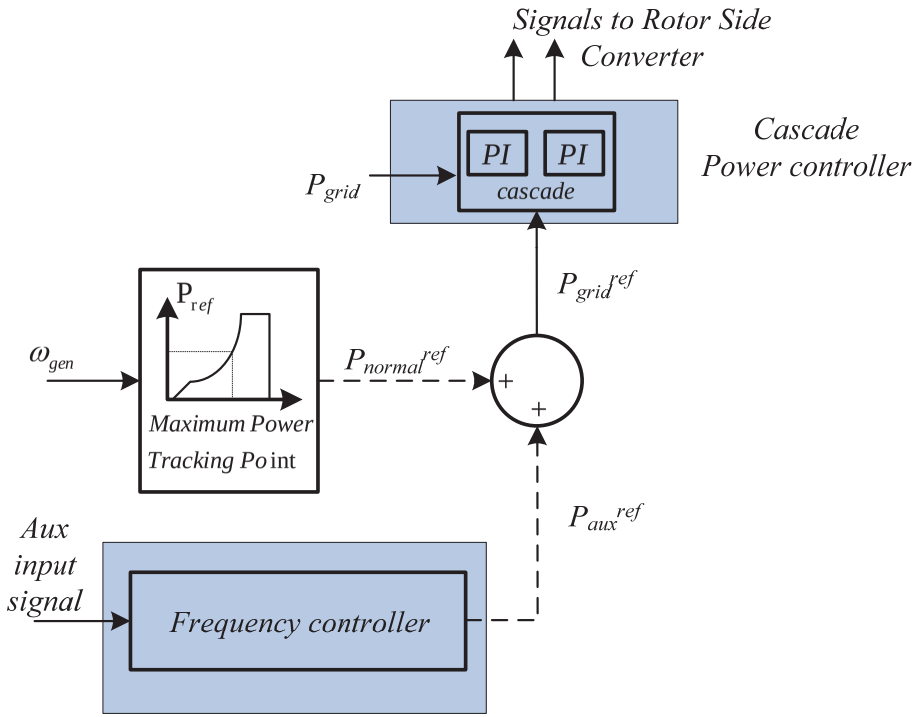


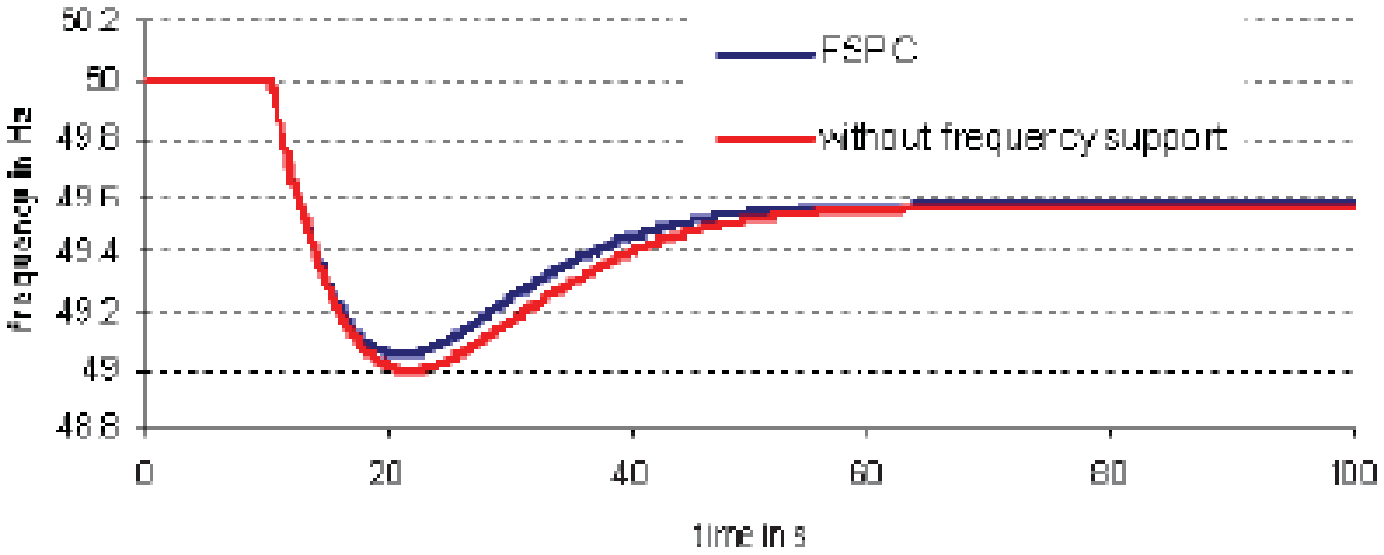
Figure 6 Development in frequency in Nordel following production outage

Frequency control scheme



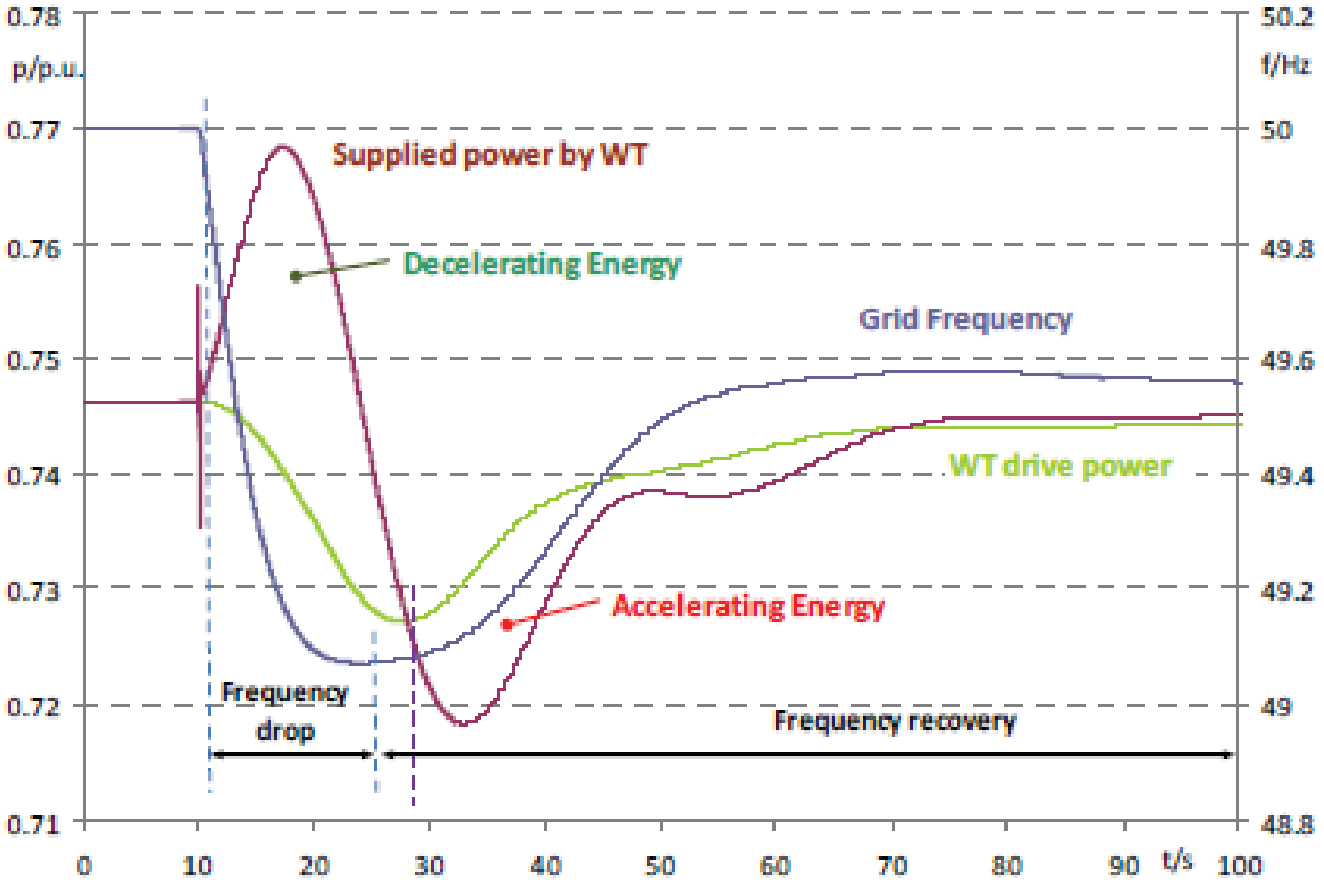
General frequency control scheme

Droop control



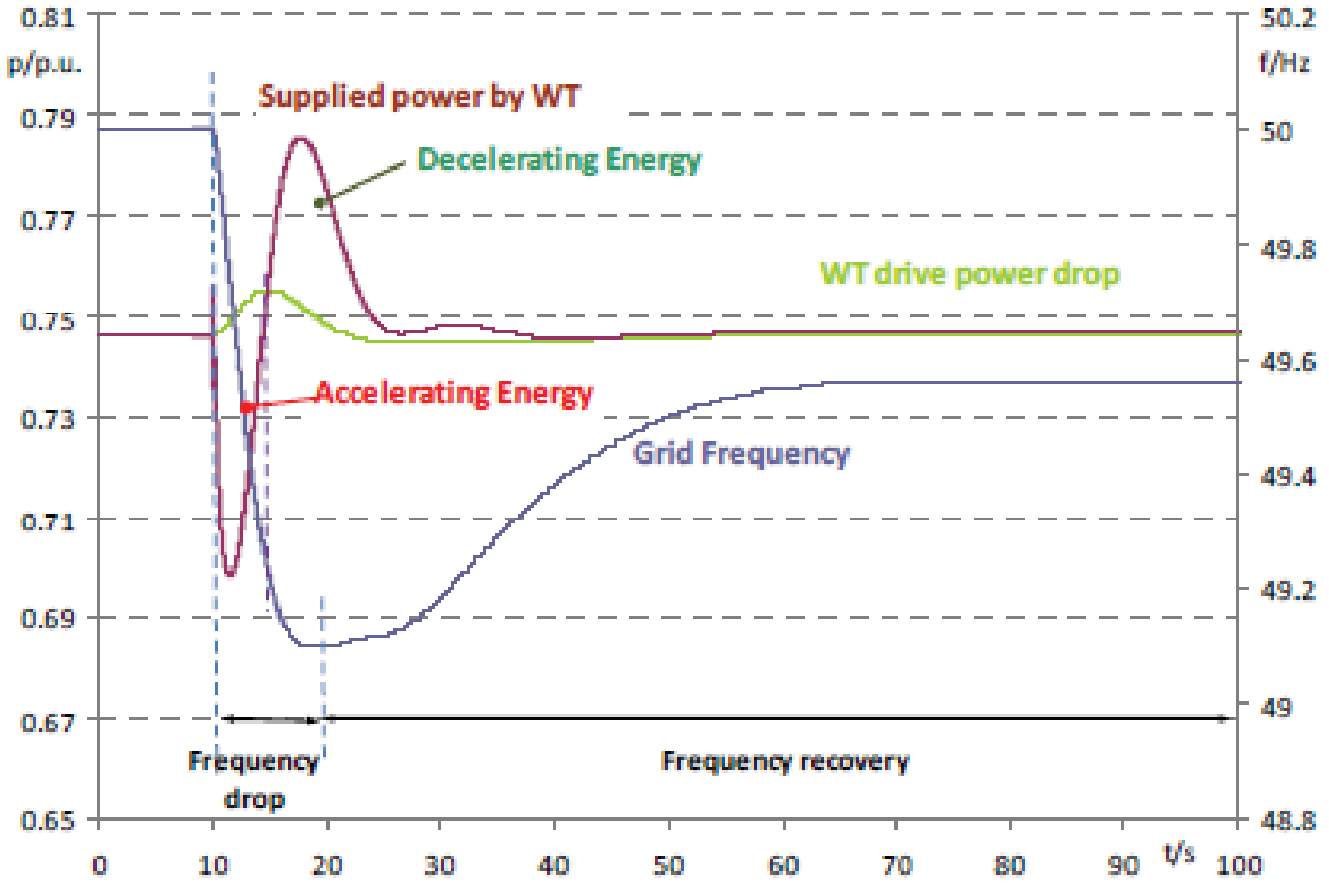
Source :I. Erlich, 2010

Kinetic energy 1 (virtual inertia)



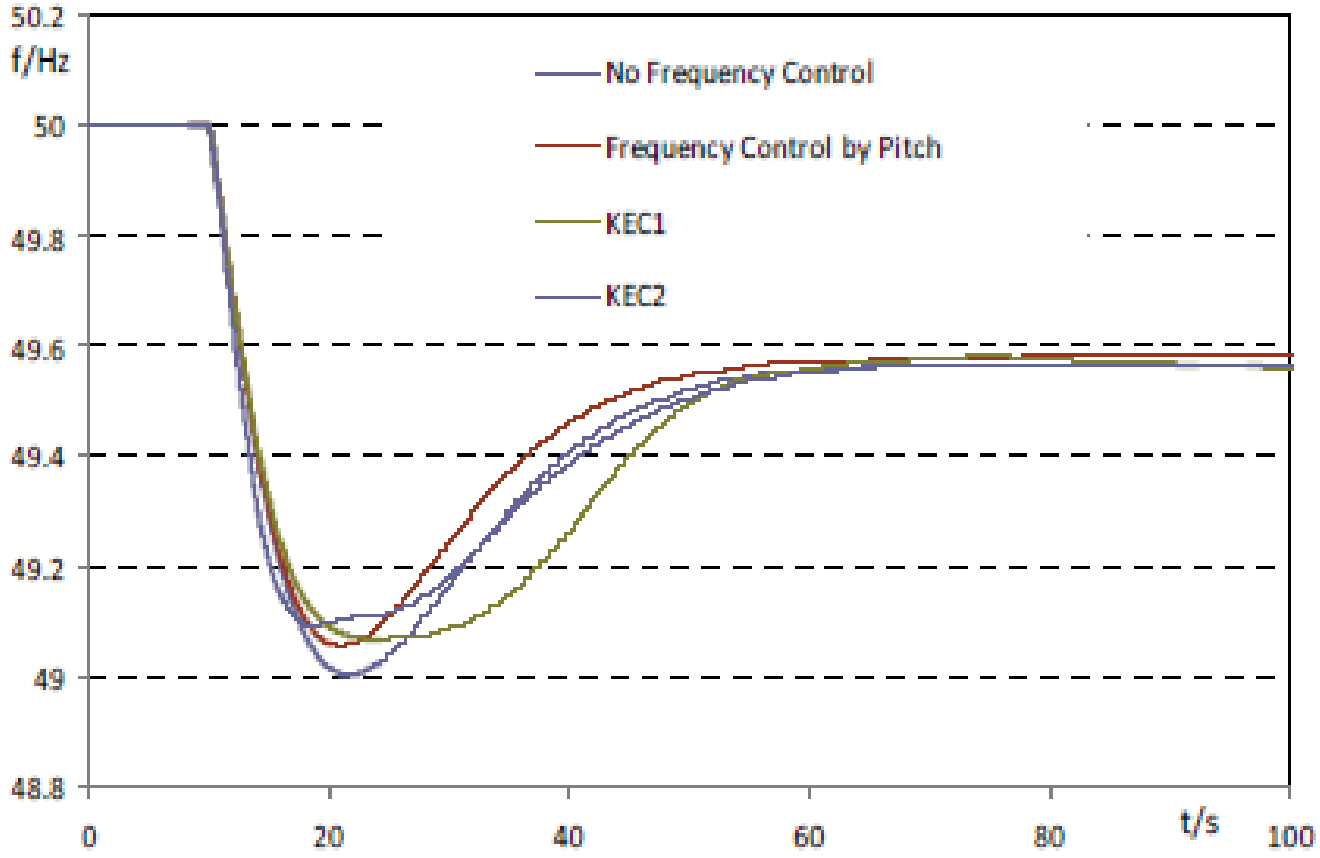
Source :I. Erlich, 2010

Kinetic energy 2 (temporary droop)



Source :I. Erlich, 2010

Frequency control

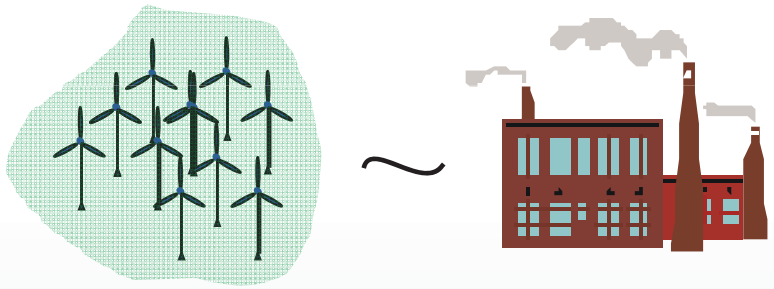


Source :I. Erlich, 2010

Enhanced Ancillary Services from Wind Power Plants

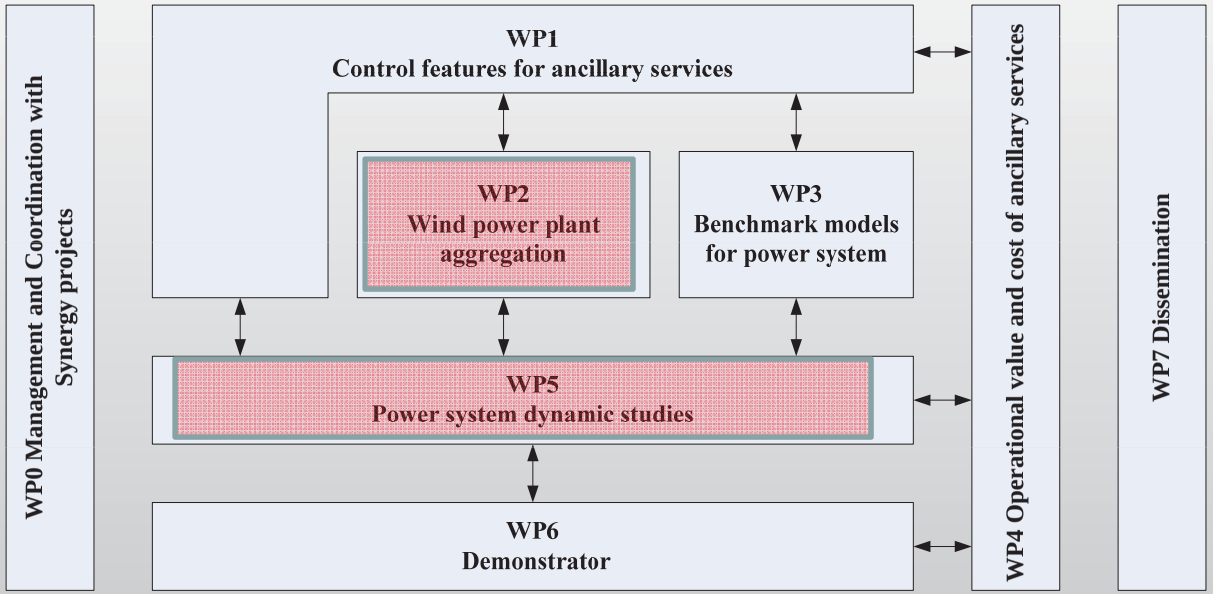
(*EASEWIND*)

To develop, asses and demonstrate technical solutions for enabling wind power to have similar power plant characteristics as conventional generation units.



Partners:

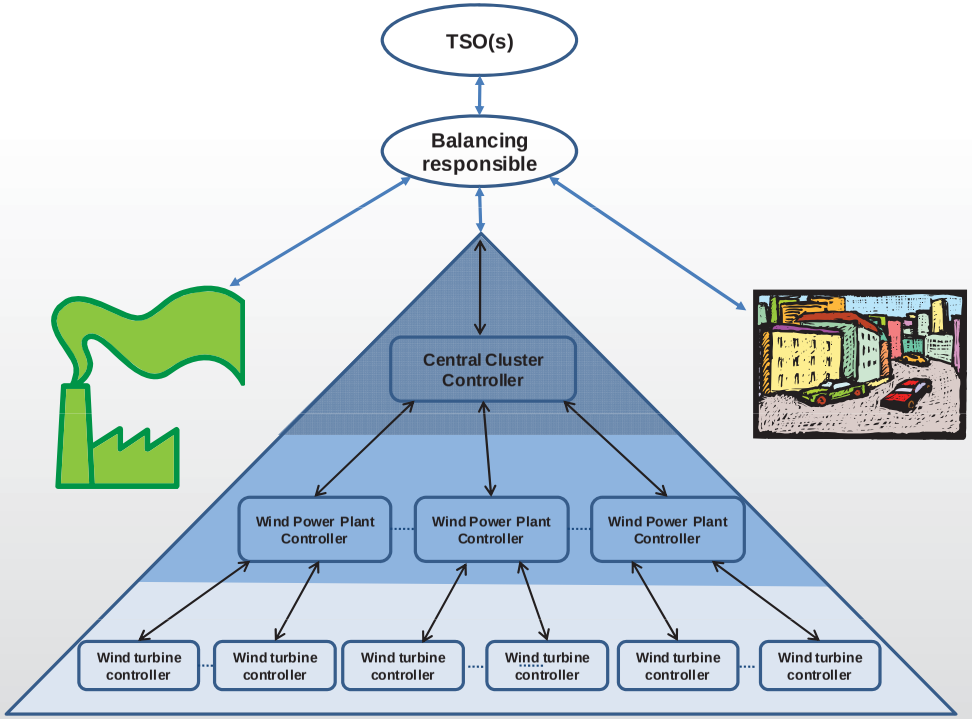
- Vestas Power Programme
- Risø DTU – VES and IES
- DTU/IMM
- AAU/IET



DC grids for integration of large scale wind power *(OffshoreDC) – www.offshoredc.dk*

Overall objective:
To develop and apply the Voltage Source Converter (VSC) based HVDC grid technologies in the deployment of offshore wind power.

Partners:
- **Risø DTU – VES**
- **Vestas Technology R&D**
- **DTU Elektro**
- **ABB**
- **DONG Energy**
- **EnergiNet.dk**
- **Chalmers University**
- **SINTEF**
- **VTT**



Cluster control (Ph.D student):
Communication and control in clusters of wind power plants connected to HVDC offshore grids *(control system architecture, allocation of control tasks, communication protocol)*